Reaction sequence of thin Ni films with (001) 3C-SiC

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Nickel is frequently used as a contact to SiC. We investigate the reaction sequence between Ni and cubic SiC at annealing temperatures between 400°C and 700°C in vacuum.

The films are analyzed by 3.2 MeV $^4He^{++}$ backscattering spectrometry and secondary ion mass spectrometry to determine elemental depth profiles, X-ray diffraction to characterize reaction compounds, and cross sectional transmission electron microscopy to visualize the microstructure of the reacted layer.

We find that a reaction starts after annealing at 450°C for 30 min with an outdiffusion of carbon through the nickel layer up to the surface where it remains stable during additional annealing.

The same annealing temperature leads to interdiffusion of Ni and Si with formation of the Ni_3Si phase. $Ni_{31}Si_{12}$ starts to form at 450°C after annealing during 120 min, and it is the only detected phase in the sample annealed at 500 C. The Ni_2Si phase, which is the thermodynamically stable phase with SiC together with elemental C, starts to grow down from the surface toward the SiC at 600°C, and about half of the previous layer is consumed after 30 min. After the 700°C/30 min anneal only this phase can be detected. At this stage, the carbon distribution still shows an accumulation on the surface, followed by a concentration sink underneath and an almost constant distribution through most of the remaining depth of Ni_2Si down to the interface. In terms of the microstructure the film shows two major distinct layers, an upper part with very fine structure, and a lower part of distinctly columnar structure.